Contents: Radiation-Generating Devices

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

Section	Overview of Content (see section for full process)
Introduction	
1. Commissioning Radiation-Generating Devices (RGDs)	• Implement RGD program and appoint a Department/Division RGD Custodian. • Classify and register RGD. • Complete PDR/SOP/ESR. • Review and approve PDR/SOP/ESR. • Ensure design reviews are completed and approved. • Coordinate initial safety inspection, ORE, or ESR walkdown, if applicable.
2. Operating Radiation-Generating Devices (RGDs)	• Ensure training is current. • Notify FS Representative prior to any shielding modification. • Perform initial radiological survey; affix RGD Survey Tag to RGD. • Coordinate routine safety inspections and radiological surveys of RGD. • Coordinate a radiological survey of the RGD. • Terminate unsafe RGD operations and notify appropriate personnel. • Notify Master RGD Custodian and ESR Coordinator of any change in RGD status.
3. Disposing and Decommissioning of Radiation-Generating Devices (RGDs) and Facilities	• Disable RGD before disposal. • Secure source (e.g., locking), if necessary. • Notify Master RGD Custodian of disposal of RGD. • Notify Master Source Custodian of disposal of sealed radiation sources. • Determine if ERE is required and/or formal closeout of ESR. • Update EUA for building/facility

	• Update PSA for building/facility.
4. Maintaining Records	• Document all maintenance, service, and repair in logbook. • Retain records for life of RGD. • Maintain Laboratory RGD records.

Definitions

Exhibits
Guidance for Radiation-Generating Device (RGD) Procedures
NSLS Sample Procedure for Radiation-Generating Devices (RGDs)
Procedure/Documentation Requirements (PDRs) Template for Radiation-Generating Device (RGD) Operation
Radiation-Generating Device (RGD) Exempt Label
Radiation-Generating Device (RGD) Identification Label
Radiation-Generating Device (RGD) Program Exemptions
Radiation-Generating Device (RGD) Survey Tag

Forms
BNL Radiation-Generating Device (RGD) Registration Form
Radiation-Generating Device (RGD) Authorized User Qualification List
Radiation-Generating Device (RGD) System-Specific Training Checklist

Training Requirements and Reporting Obligations

This subject area contains training requirements. See the Training and Qualifications Web Site.

This subject area does not contain reporting obligations.

References

10 CFR 835, Occupational Radiation Protection

Accelerator Safety Subject Area

BNL Radiological Control Manual

ES&H Standard 1.5.2, Design Criteria for Electrical Equipment

Facility Use Agreement Subject Area

Laser Safety Subject Area

Operational Readiness Evaluation (ORE) Subject Area

Operational Readiness Evaluation (ORE) Subject Area

Sealed Radioactive Source Control Subject Area

Space Management Subject Area

Work Planning and Control for Experiments and Operations Subject Area

Standards of Performance

Managers shall analyze work for hazards, authorize work to proceed, and ensure that work is performed within established controls

All staff and users shall identify, evaluate, and control hazards in order to ensure that work is conducted safely and in a manner that protects the environment and the public.

All staff and users shall ensure that they are trained and qualified to carry out their assigned responsibilities, and shall inform their supervisor if they are assigned to perform work for which they are not properly trained or qualified.

All staff and users shall conduct work within the facility-specific operational boundaries specified in Facility Use Agreements.

All staff and guests shall ensure that personnel radiation exposure is maintained As Low As Reasonably Achievable (ALARA).

All staff and guests shall promptly report accidents, injuries, ES&H deficiencies, emergencies, and off-normal events in accordance with procedures

Management System

This subject area belongs to the **Radiological Control** management system.

Back to Top

1.0-072004/standard/3w/3w00t011.htm

Introduction: Radiation-Generating Devices

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

Many devices that are in use at BNL produce ionizing radiation either intentionally or incidentally as a result of their normal routine operation. This subject area describes the procedures for working with radiation-generating devices (RGDs) at BNL, including registration, commissioning, and decommissioning. Accelerators with energies greater than 10 MeV are covered in the Accelerator Safety Subject Area. Medical (diagnostic and therapeutic) devices must be registered under the RGD program, but are exempt from most of the requirements in this subject area. Laser radiation safety is covered in the Laser Safety Subject Area. Sealed, radioactive sources as irradiators that are properly labeled and stored, and are not in use as operational RGDs are covered in the Sealed Radioactive Source Control Subject Area.

Back to Top

1.0-072004-/standard/3w/3w00i011.htm

Subject Area: ***Radiation-Generating Devices***

1. Commissioning Radiation-Generating Devices (RGDs)

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

Applicability

This information applies to staff who procure, operate, use, and dispose of radiation-generating devices (RGDs).

Required Procedure

Staff who plan an operation involving the use of RGDs must provide a workspace that is consistent with the requirements of the appropriate engineering and administrative controls. Staff must refer to the Work Planning and Control for Experiments and Operations Subject Area when planning experimental work, as well as ES&H Standard 1.5.2, Design Criteria for Electrical Equipment.

Step 1	The Department Chair/Division Manager appoints a Department/Division RGD Custodian for Departments/Divisions planning to maintain and operate one or more RGDs.
Step 2	The Lead Experimenter (LE)/Responsible Person (RP) of the RGD notifies the Department/Division RGD Custodian prior to bringing any RGD onsite.
Step 3	The Department/Division RGD Custodian notifies the Facility Support (FS) Representative in advance of bringing any RGD onsite, regardless of ownership.
Step 4	The Department/Division RGD Custodian and the Master RGD Custodian classify and register the RGD using the BNL RGD Registration Form. Copies of this documentation must be maintained by both individuals. **Note:** The Department/Division RGD Custodian notifies the Master RGD Custodian of any change in status of an RGD.

Step 5	The LE/RP completes the Procedure/Documentation Requirements (PDR)/standard operating procedure (SOP), and/or the Experimental Safety Review (ESR) for the preoperation and initial operation of the RGD. The following items should be included: • Type of device; • Manufacturer; • Model number; • Serial number; • Operating parameters: voltage, current, activity, etc.; • Type and energy produced; • Mechanism, for incidental devices, by which radiation is produced; • Location(s); and • Names of supervisor and authorized owners/operators; • Additional guidance for completing the PDR/SOP/ESR is provided in the exhibits Guidance for Writing Radiation-Generating Device (RGD) Procedures and Procedure/Documentation Requirements (PDR) Template for Radiation-Generating Device (RGD) Operation.
Step 6	Master RGD Custodian and Facility Support Services staff review PDR/SOP/ESR for the RGD.
Step 7	The ESH Coordinator/ Experiment Review Coordinator (ERC) approves the RGD PDR/SOP/ESR for the Department/Division.
Step 8	The Department/Division RGD Custodian and ERC ensure design reviews of devices, projects, and work controls are completed and approved (see the Work Planning and Control for Experiments and Operations Subject Area.
Step 9	Ensure the FUA for the building or facility is updated, as appropriate. See the Facility Use Agreements Subject Area for more information. See the Operational Readiness Evaluation (ORE) Subject Area to determine if a Beneficial Occupancy Readiness Evaluation (BORE) is necessary.
Step 10	The Department/Division RGD Custodian, LE/RP of the RGD, and ERC coordinate an initial safety inspection, Operational Readiness Evaluation (ORE), or Experimental Safety Review (ESR) walkdown if applicable. See the Operational Readiness Evaluation (ORE) Subject Area for more information.
Step 11	Facility Support performs the initial radiological survey. The Department/Division RGD Custodian affixes an RGD Identification Label (supplied by the Master RGD Custodian or FS Representative) to the RGD on or near the controls (power supplies) of the RGD and includes the following information, at a minimum: • The RGD identification number assigned by the Master RGD Custodian

Operational Readiness Evaluation (ORE) Subject Area

| Go to Previous Page | Continue to Next Page |

Back to Top

1.0-072004/standard/3w/3w02d011.htm

Subject Area: ***Radiation-Generating Devices***

2. Operating Radiation-Generating Devices (RGDs)

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

Applicability

This information applies to staff who operate or supervise the operation of radiation-generating devices (RGDs).

Required Procedure

Step 1	The Master RGD Custodian provides training for Department/Division RGD Custodians.
Step 2	The Lead Experimenter (LE)/Responsible Person (RP) of the RGD ensures authorized users of all RGDs have received device-specific training for the RGD they operate, in addition to GERT, as a minimum, or Radiological Worker I every two years, as applicable. The RGD Lead Experimenter (LE)/Responsible Person (RP) conducts an orientation for the trainee of the RGD operational requirements, documents the completion of training on a Radiation-Generating Device (RGD) System-Specific Training Checklist, and maintains the records. The LE/RP of the RGD ensures that a current list of all authorized RGD operators (see the exhibit Radiation-Generating Device (RGD) Authorized User Qualification List) is posted on or near the RGD.
Step 3	The LE/RP of the RGD ensures all RGDs are operated and documented in accordance with applicable

	• Facility Use Agreements (FUA); • RGD procedures; • Radiological Work Permits; • Experimental Safety Review document.
Step 4	Facility Support performs the radiological survey. The Department/Division RGD Custodian affixes a RGD Survey Tag (supplied by the Facility Support (FS) Representative) to the RGD on or near the controls (power supplies) of the RGD and includes the following information, at a minimum: • The next routine survey due date, if applicable; • The next routine interlock test date, if applicable; • The energy settings for the RGD (both maximum and as tested), if applicable.
Step 5	The LE/RP of the RGD notifies the Facility Support (FS) Representative and Experiment Review Coordinator (ERC) and schedules a resurvey prior to any restart and/or shielding modification.
Step 6	The Department/Division RGD Custodian, LE/RP of the RGD, and RGD Operator ensure RGDs are operated only when valid RGD Survey Tags are properly attached.
Step 7	The Department/Division RGD Custodian and FS Representative coordinate routine safety inspections, interlock tests, and radiological surveys of the RGD at six month intervals, as a minimum.
Step 8	The RGD Operator notifies the FS Representative and the ERC of any changes in workplace conditions or unplanned events.
Step 9	The RGD Operator secures RGD operation in the event of any unsafe condition and immediately reports the condition to the supervisor, FS Representative, and RGD Custodian.
Step 10	Notify the Department/Division RGD Custodian and the FS Representative if the operation of the RGD is terminated for any reason.
Step 11	The LE/RP of the RGD notifies the Department/Division RGD Custodian of any change in the RGD status including placement of the device out of service (OOS), modifications, transfer, storage, disposal, or loss of an RGD. **Note:** The Department/Division RGD Custodian notifies the Master RGD Custodian and ERC (if the device is connected to a particular experiment) of any change in status of an RGD.

References

Operational Readiness Evaluation (ORE) Subject Area

| Go to Previous Page | Continue to Next Page |

Back to Top

1.0-072004/standard/3w/3w02d011.htm

Send a question or comment to the SBMS Help Desk
Disclaimer

Subject Area: ***Radiation-Generating Devices***

3. Disposing and Decommissioning of Radiation-Generating Devices and Facilities

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

Applicability

This information applies to Department/Division RGD Custodians.

Required Procedure

Step 1	Before disposing of the RGD, disable it in such a way that it cannot be used without servicing by a qualified technician.
Step 2	For an RGD containing radioactive material, physically secure the source (e.g., locking) to prevent inadvertent radiation exposure. All radiation warning signs and labels must be left on the RGD. A radiation label must remain on the device until the source has been removed and a radiological survey shows no residual contamination.
Step 3	Notify the Master RGD Custodian of the disposal of the RGD and provide copies of the disposition records (e.g., shipping records, waste records, RWCFs, etc.).
Step 4	Notify the Master Source Custodian of the disposal of any sealed radiation sources associated with the RGD (see the Sealed Radioactive Source Control Subject Area).
Step 5	If the RGD is also part of a space or facility that is meant for decommissioning, determine if an Exit Readiness Evaluation (ERE) is required (see the exhibit Criteria for Return of Space in the Space Management Subject Area) and/or formal closeout of the Experimental Safety Review (ESR).
Step 6	Ensure the Facility Use Agreement (FUA) for the building or facility is updated, as appropriate. See the Facility Use Agreement Subject Area for more information

appropriate. See the Facility Use Agreement Subject Area for more information.

References

Facility Use Agreement Subject Area

Sealed Radioactive Source Control Subject Area

Space Management Subject Area

| Go to Previous Page | Continue to Next Page |

Back to Top

1.0-072004/standard/3w/3w03d011.htm

Subject Area: ***Radiation-Generating Devices***

4. Maintaining Records

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

Applicability

This information applies to staff who operate or supervise the operation of radiation-generating devices (RGDs).

Required Procedure

Step 1	The RGD Operator documents all maintenance, service, and repair of the RGD in the RGD logbook.

Step 2	The Lead Experimenter/Responsible Person retains the following records for the life of the RGD:
	
	• Maintenance history of all RGDs, including descriptions of all maintenance work that affects the radiation-generating capabilities of the RGD;
	• Maintenance and operations logbook that should include
	  ○ Results of operational checks of the safety devices;
	  ○ Safety inspections;
	  ○ Maintenance, service, and repair to the device.
	• Schematics, safety device specifications, and diagrams;
	• Manufacturer's safety instructions;
	• Findings and corrective actions;
	• RGD System-Specific Training Checklists;
	• RGD Authorized User Qualification Lists.
	
	The Department/Division RGD Custodian retains the registration forms and disposition records for the life of the RGD.
	
	The Radiological Control Division retains the radiological survey records for 75 years.

Step 3	The Master RGD Custodian maintains the Laboratory records on RGDs.

| Go to Previous Page |

Back to Top

1.0-072004/standard/3w/3w04d011.htm

Subject Area: ***Radiation-Generating Devices***

Guidance for Radiation-Generating Device (RGD) Procedures

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

This exhibit provides general guidance for the construction of written procedures (procedure/documentation requirements, standard operating procedures) for radiation-generating devices, including normal operation as well as those items which need to be included for operation and alignment. Maintenance issues where applicable are to be addressed as well. In general, only the procedures specified by the manufacturer of the device should be used. When alternate procedures have been put in place by the person in charge they must have the approval of the Department/Division. Variations made to the procedure must be reviewed and approved by the person in charge and the Department/Division.

General Operation Requirements

- No x-ray tube shall be operated without a suitably shielded housing to restrict the primary beam or secondary radiation to a well defined beam.
- If maintenance/service is to be performed on the device after reassembly, the system shall be checked by the person in charge with particular attention paid to the alignment of shielding, shutters,and collimators. Lead parts shielding should be checked for damage distortion or corrosion.
- Any device for use with an x-ray tube shall be regarded as a nonstandard accessory unless it is a compatible component manufactured specifically to fit the radiation source housing used. It is recommended that no new accessory be aligned or operated until the manufacturer's procedures have been reviewed by the operators and the person in charge (i.e., supervisor).
- Devices that have had work performed on them, which involves the removal or modification of shielding, shall be resurveyed by a Radiological Control Technician upon restart to ensure that the shielding and configuration of the device has been maintained. This also applies also for newly installed units.

Alignment/Maintenance Requirements

- Alignment procedures recommended by the manufacturer shall be used when available. Special alignment procedures shall not be used unless approved by the ESH

available. Special alignment procedures shall not be used unless approved by the ESH Coordinator, person in charge of the system or Departmental Safety Review.
- No operation involving removal of cover shielding materials or tube housings, or modifications to shutters, collimators or other work is to be performed on the tube housing without ascertaining that the tube is off. The x-ray power switch shall be used rather than the interlocks for shutdown in preparation for repairs. Where the work involves systems utilizing radioactive material as the primary source of radiation, the work may need to fall under a Radiation Work Permit.
- A radiation survey shall be requested if it is suspected that the alignment procedure will result in an increase in radiation levels, causing a change in radiological boundaries.

Note: Repairs should be carried out on uncluttered surfaces so that any pieces left out during reassembly will be conspicuous.

Items to be included, as appropriate, into written operating procedures for radiation-generating devices (RGDs)

General

- All shields, interlocks and safety devices; shall be inspected periodically and appropriately serviced as per the manufacturer's recommendations;
- Maintain all exposures ALARA;
- Methods and occasions for controlling access;
- Methods and occasions for locking and securing radiation sources;
- Inspection and maintenance of radiation producing equipment;
- Requirements of training of personnel including device specific training;
- Calibration or alignment of the useful beam; RGD manufacturer's instructions should be used for developing these procedures.

Normal Operation

- Methods for performing checks to determine that access controls and safety devices are operational (i.e., operational inspections);
- Methods to perform checks and to define response actions for any stationary (area) monitor or device that is used for individual safety;
- Methods to perform functional inspections and checks of the safety devices (e.g., interlocks, warning lights, switches, etc.);
- Identification and instructions in the use of radiation protection safety devices and equipment associated with the installation.

Emergency Conditions

- Types of emergencies that may potentially be encountered, including worst-case, individual overexposure, malfunctioning of equipment or safety devices, and exposure to individuals who are not radiological workers;
- Identification of the individuals and organizations that will be notified in the event of an emergency.

Emergency actions for those RGD installations which need to be energized to produce radiation should include the following conditions:

- Failure of an RGD to turn off;
- Fire involving the installation;
- Radiation levels outside the installation in excess of prescribed limits;
- Failure to evacuate personnel from an exposure room prior to producing radiation.

Emergency actions for sealed radioactive sources, or small particle accelerators (that use targets in which radioactivity can be induced), or neutron generators should consider the following conditions:

- Loss of radioactive material containment (airborne or surface contamination);
- Loss of the sealed radioactive source, or of the source becoming jammed in an unshielded position;
- Fire involving the installation;
- Radiation levels outside the installation in excess of prescribed limits;
- Failure to evacuate personnel from an exposure room prior to producing radiation.

Back to Top

Subject Area: ***Radiation-Generating Devices***

NSLS Sample Procedure for Radiation-Generating Devices (RGDs)

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

The exhibit NSLS Sample Procedure for Radiation-Generating Devices (RGD) is provided as a Word or PDF file.

Back to Top

1.0-072004/standard/3w/3w06e011.htm

Subject: Normal Operating, Alignment, and Interlock Test Procedures: NSLS X-ray Generator for Crystal Orientation, Building 535C (Basement)

Prepared By:	Reviewed By:	Approved By:
Richard Greene	Chris Weilandics	W. Robert Casey
Nicholas F. Gmür	Steve Musolino	

*Document must contain approved signatures for validity

NSLS Sample Procedure for Radiation-Generating Devices (RGDs)

Coordination of Crystal Orientation Facility

The Steward of the Crystal Orientation Facility shall coordinate the day-to-day affairs of the Crystal Orientation Facility. These will include design modifications (under the direction of Technical and Scientific Supervision), component replacements, maintenance, interlock tests, radiation surveys, training of new operators, as well as maintaining complete and accurate documentation.

Equipment

Type of Equipment: Transformer for X-ray generator*
Manufacturer: Diffractis 601 ENRAF NONIUS
Model Number: 601004-5-14
kV Range: 15 - 60 kV
mA Range: 4 - 30 mA
Electrical Requirements: 220 V, 50 or 60 Hz single phase
Power consumption: 1800 Watts at full load
PCB Concentration: <2 ppm (~15 gallons of oil; sampled 04/2000)
Location: Bldg. 535C - Room C6A
NSLS Contact: Rick Greene (x3751, Bldg. 725D)
*In use

Type of Equipment: Transformer for X-ray generator*
Manufacturer: Diffractis 601 ENRAF NONIUS
Model Number: 601922-3-2
kV Range: 15 - 60 kV
mA Range: 4 - 30 mA
Electrical Requirements: 220 V, 50 or 60 Hz single phase
Power consumption: 1800 Watts at full load
PCB Concentration: <2 ppm (~15 gallons of oil; sampled 04/2000)
Location: Bldg. 535C
NSLS Contact: Rick Greene (x3751, Bldg. 725D)
*Spare; not currently in use

Type of Equipment: Rigaku enclosure and interlock system

Documentation

a) X-Ray Diffraction Safety Generator, Diffractis 601, Operating Instructions, Enraf Nonius Inc.
- Electronic schematics
- Interface schematics for Rigaku interlock system with Diffractis 601

b) Rigaku Corporation Radiation Shield Instruction Manual, Cat. No. 4621, Manual No. ME410BW4

c) Normal Operating, Alignment, and Interlock Test Procedures: NSLS X-ray Generator for Crystal Orientation, Building 535C (Basement); LS-ES-0001. This procedure will be maintained under the NSLS document control system.

Operational Safety Requirements

1. Operator must be current in NSLS Facility Specific Training as well as General Employee Radiation Training (or NSLS equivalent).

2. Operator must be fully trained in the use of this Radiation Generating Device - RGD (signature/date on Training page of logbook; counter-signed by Steward of the crystal orientation facility).

3. Operator must be wearing a personal radiation badge (TLD).

4. Normal operations involve the presence of at least one operator. Unattended operations are also possible providing:
a) Radiation enclosure is fully closed and interlocked,
b) Door to room is locked, and
c) Unattended Operations for Beamline ("pink") card is properly filled out and displayed on outside of room door (maximum validity = 24 hrs.).

5. There is no need for a formal, check-station search procedure as the X-ray enclosure is table-top sized and fully viewable by the operator.

Off-Normal/Emergency Operation

1. The interlock system protects the operator against inadvertent access to potentially harmful X-rays by closing the X-ray beam shutter and turning off the X-ray generator power supply.

2. If any enclosure panel is opened during normal operation without using the proper interlock by-pass procedure, power to the generator is lost and the X-ray beam shutter locks closed until reset.

3. If any shutter position indicator lamp fails, power to the generator is lost and the X-ray beam shutter locks closed until reset.

4. If the "X-rays On" lamp in the enclosure fails, power to the generator is lost and the X-ray beam shutter locks closed until reset.

5. Should the RGD fail to turn off during any of the above conditions or when the operator attempts the shutdown procedure, then the "Mains" button on power generator itself should be turned off and a diagnosis should take place to determine and correct the source of the problem.

6. If radiation levels >500 cpm are measured inside or outside the radiation enclosure, the electric shutter must be closed and additional shielding must be devised in collaboration with a Radiological Control Technician who may conduct a radiation survey.

7. If any part of an operator's body is directly exposed to the X-ray beam itself, the operator must close the beam shutter and immediately inform Radiological Control Division personnel assigned to the NSLS.

8. If a smoke condition or fire occurs in the power supply or the radiation enclosure:
   - Call x2222 to notify BNL Fire/Rescue;
   - Also, call x2550 to notify the NSLS Control Room personnel to manage the emergency.
   - Unplug generator from electrical socket on adjacent wall;
   - Use a fire extinguisher if you feel competent and it is safe to do so;
   - Evacuate if conditions warrant;

Note:
- Two sprinkler heads cover the crystal alignment room;
- Smoke detectors in adjacent basement area;
- A "B,C" fire extinguisher is located in the room adjacent to the crystal alignment room;
- An "A,B,C" fire extinguisher is located in the hallway leading to the building exit stairs;
- The building exit is located to the left of the doors coming out of the alignment room;
- A fire alarm pull box is located next to the building exit door.

X-ray Generator Normal Operating Procedures:

Start Up:

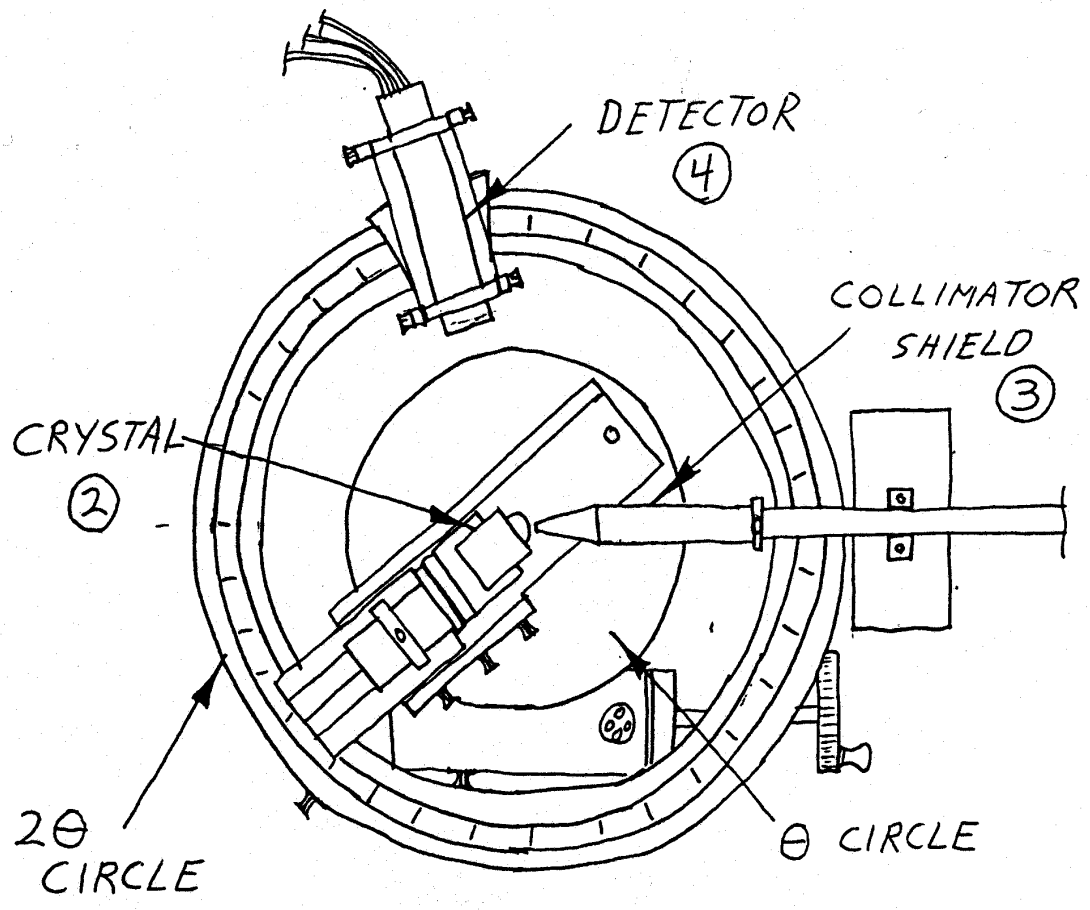
1. Enter date, name, work to be performed in Log Book.
   NOTE: **Sign out and wear a ring dosimeter ONLY IF hands-on manipulation of equipment takes place inside the enclosure with the interlock bypassed, e.g. X-ray beam ON.**

2. With all power off, set up item to be aligned on the "θ Circle".

3. Slide "Collimator Shield" to within 10 mm or less of the crystal surface and tighten the shield clamp screw in order to prevent hand-access.

4. Position "Detector" on "2θ Circle".

Figure 1 (below)



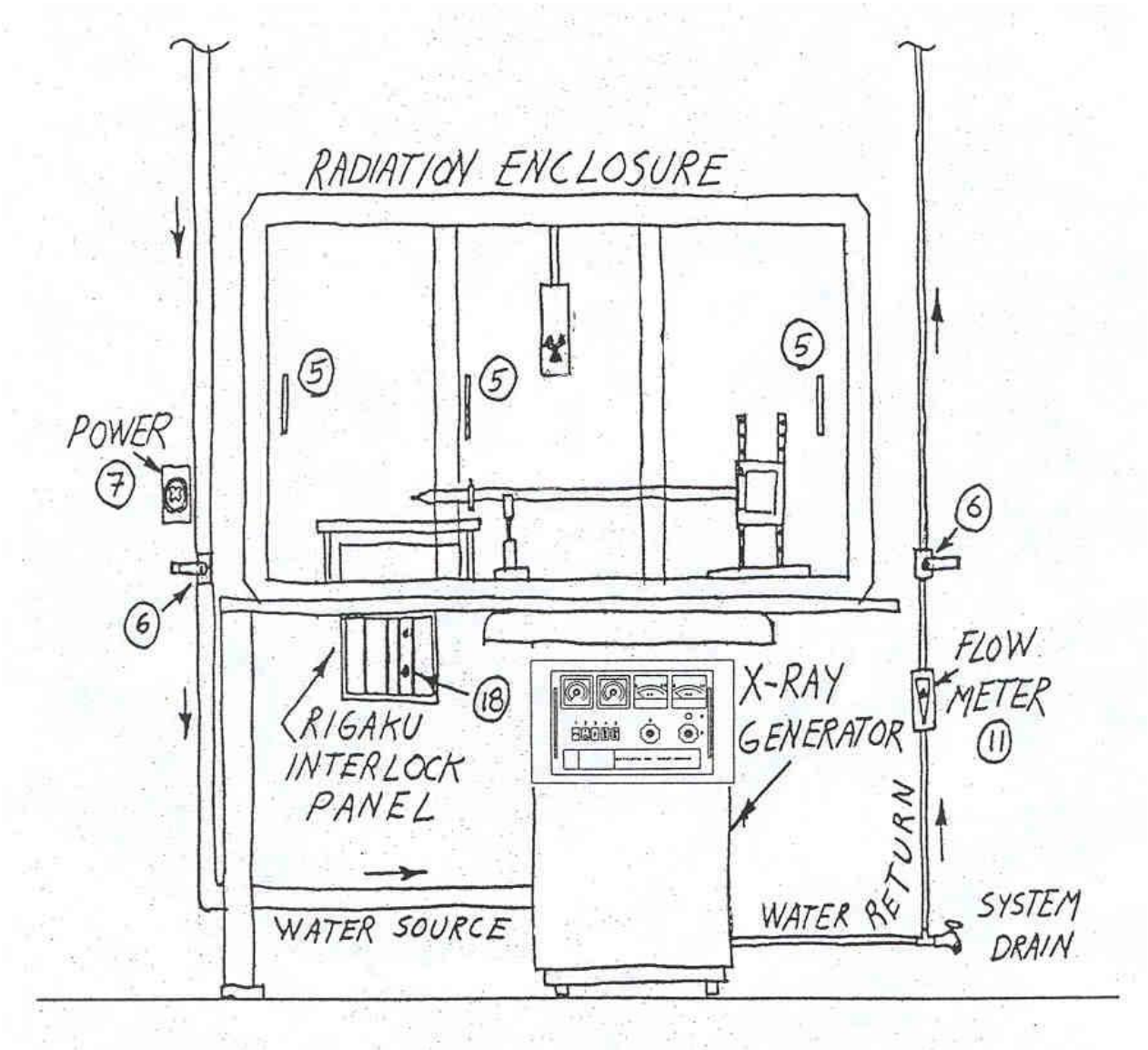


Figure 2 (above)

5. Completely close all seven sliding doors on the enclosure.

6. Open the water tap.

7. Plug X-ray generator power cord into 208V receptacle.

8. Depress the button “Mains” (1).

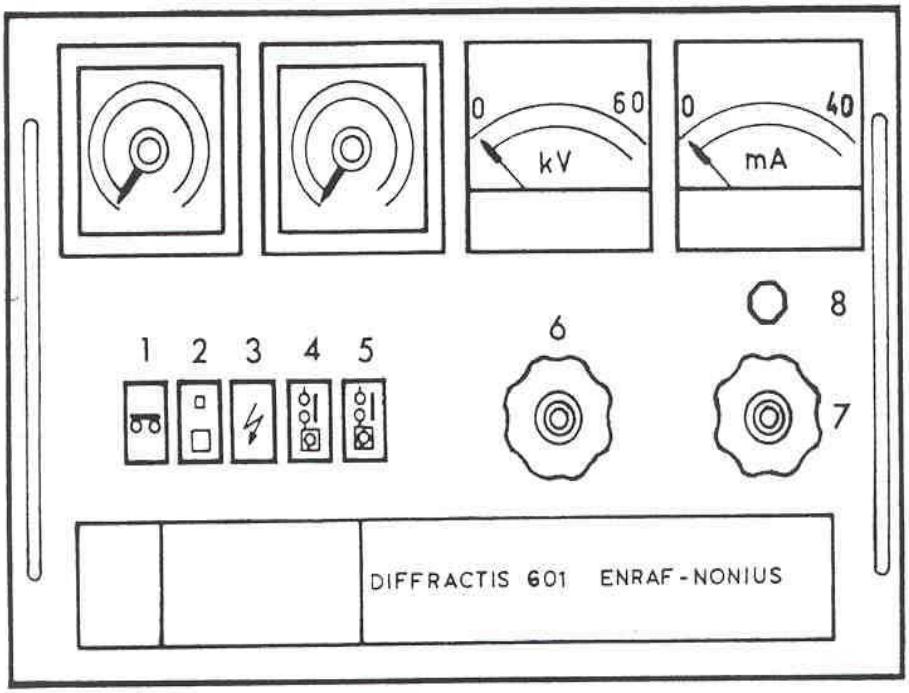


Figure 3 (above)

10. Depress the focus selector switch (2). The red fine focus split display will light up. This is a two position switch – “In” position for fine focus and “Out” position for normal focus tubes (green).
Generator must be started in the fine focus position, even when normal focal tube is used

11. The two timer switches (4 and 5) will be operative if left in the “Out” position. If one or both are pushed in, it is illuminated and indicates that the timer circuit is bypassed.

    The front of the timer has a button marked with an arrow. If this arrow is turned to fully cw (clockwise) position the timer operates on 0-1 hours; in the middle position: 0-10 hours; and in the fully ccw (counter clockwise) position: 0-100 hours.

12. Turn both mA knobs (coarse 7) and (fine 8) to full ccw position.

13. Press the high–voltage switch (3).

14. Turn kV regulator (6) fully ccw (against spring action) and hold till the high voltage switch lights up and stable water flow is established.

15. If necessary, press the fine focus switch (2) for normal focus tube.

16. Check that water flow is greater than 0.8 GPM, as read on the flow meter.

17. If internal relays will not latch, check that all enclosure doors are in their proper tracks and proper positions, then re-try.

1. Select desired Kilovolts and Milliamperes settings:
   - 22 kV and 6 mA are standard settings

   NOTE: The mA circuit can be adjusted by means of the fine and coarse adjustments.

19. Turn on "Power" switch of electric shutter control - yellow "Power" lamp should light. If a timer is used, the shutter will be closed automatically when the selected time has elapsed. If both timers are used, the timer with the longest time setting will switch off the generator as well as the shutter.

20. Press black "On" button of shutter control - two red lamps at the top of the shutter should light, and the red X-ray lamp on the shutter control box should light, - X-rays are now present within the enclosure!

21. Use the radiation survey meter to check for X-ray leakage outside the enclosure - none should be detectable - if radiation >500 cpm is detected, press the "Off" button on the shutter control box. Contact the Facility Support Representative. Devise additional shielding only <u>in collaboration with a Radiological Control Technician</u> who may conduct a radiation survey.

22. If alignment must be performed in an "Open Beam" situation, bypass the enclosure interlock by:

    a) Turning key on the "Rigaku Interlock Panel" and holding it.

    b) Slide open one enclosure panel by ≈30mm - the red "FS Release" lamp on the Rigaku panel should be flashing.

    c) Release key.

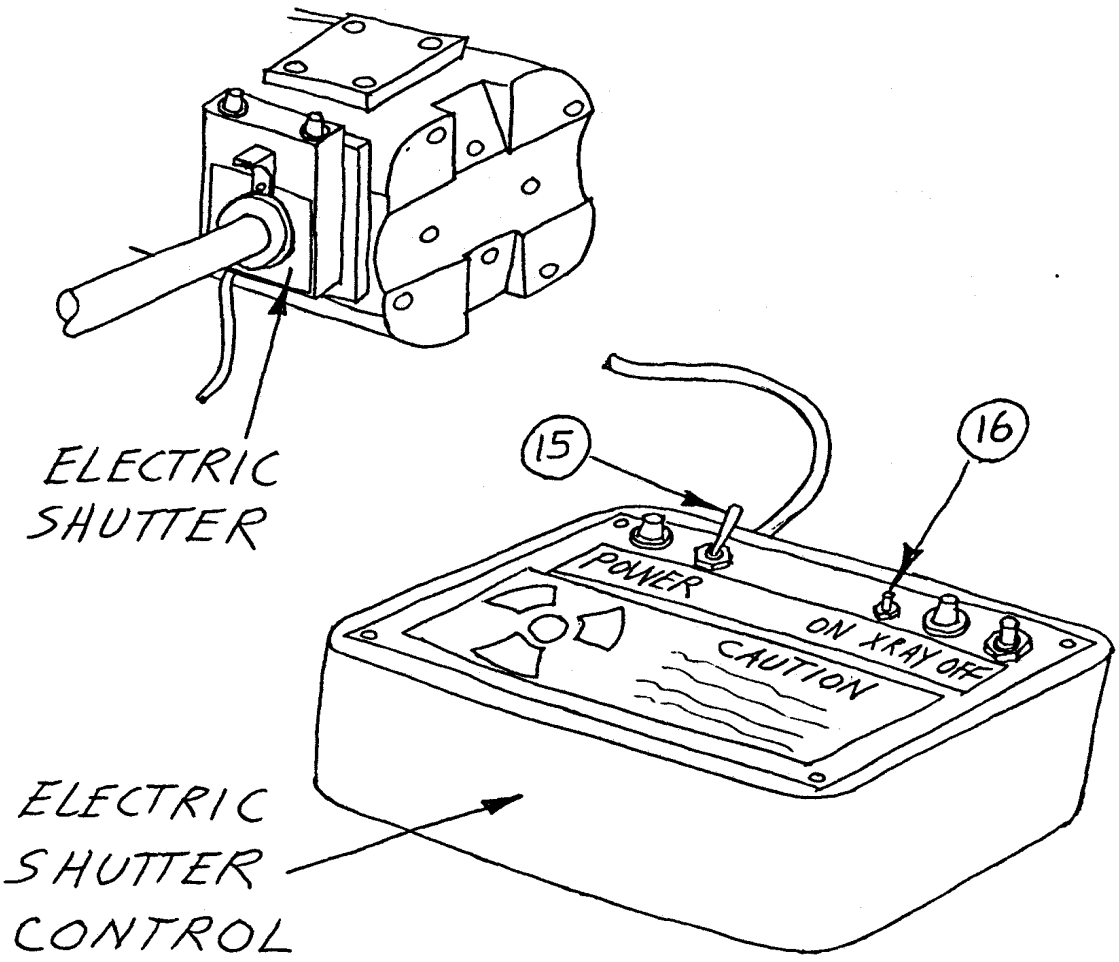


Figure 4 (above)

23. **Assure that operator has signed out and is wearing a ring dosimeter.** Use the radiation survey meter probe in one hand to check the opening produced as the enclosure panel is slid open for the required access – if radiation is detected at a rate >500 cpm, close the panel and the electric shutter, and contact the Facility Support Representative. Devise additional shielding only in collaboration with a Radiological Control Technician who may conduct a radiation survey.

24. Survey the actual region where access will be made to assure that no unusual beam scatter or diffraction is present - in no case shall the survey meter read more than 500 cpm in the region where access will be made, - if it does, close the electric shutter and contact the Facility Support Representative. Devise additional shielding only in collaboration with a Radiological Control Technician who may conduct a radiation survey.

25. Perform the crystal alignment (Note: close the electric shutter whenever X-rays are not actually needed for alignment).

Alignment Notes

Standard Alignment

Crystal alignments typically involve rotating the crystal by hand a number of degrees at a time, adjusting the crystal holder kinematic mount each time to align the planes of the crystal to the position of the incident X-ray beam. The θ ring is then rotated to deliver the maximum signal intensity to the detector making small adjustments, with X-ray beam on, to the crystal holder kinematic mount until the crystal planes are aligned to the same θ reading in 360˚ rotation.

Once the crystal is aligned, the crystal is rotated through 360° to check that all planes are aligned; rotation may be done with the X-ray beam off, checking the crystal at 90° positions.

Note, there are other forms of operation that do not necessarily involve crystal alignment.

Open X-ray Beam Inside Enclosure

The shielding enclosure and X-ray source may be used to test prototype detectors. If the X-ray beam path may be accessible by hand in this configuration, bypassing the interlock for hand access is not allowed. The detector may be aligned in the path of the beam using burn paper, a remote XYZ stage or some other method. If, however, the open beam path is limited "to within 10 mm or less" as cited above under **X-ray Generator Normal Operating Procedures**, then the same requirements as crystal alignment apply. Unattended operation is allowed using the pink card.

X-ray Beam Outside of Enclosure

Certain experiments may require that the X-ray beam be brought out of the shielding enclosure to an external equipment set-up. Such a configuration must be planned and controlled through the use of a Safety Approval Form. In all cases, the path of the X-ray beam must be fully enclosed and a radiation survey must be conducted before the experiment is allowed to commence. No unattended operation is allowed in this configuration.

Shutdown:

If no timer is used, the unit is shut off according to the following procedure:

1. Press the high voltage switch.
2. Press the "Mains" switch.
3. Remove the generator power cord from the wall receptacle.
4. Close the water inlet valve (fully CW).
5. Remove the item aligned.
6. If work is completed for the day, sign out in the logbook, lock room door, and return the key to the Steward.

X-ray Generator Alignment Procedures:

Introduction:

Alignment of the X-ray tube housing, drift tube and collimator, θ (Theta) circle, and 2θ circle in preparation for monochromator crystal orientation is a simple task, which requires open beam use of X-rays in a minimal way. This is because the alignment of these items need not be performed with high accuracy; other portions of the mechanical system govern the accuracy of the crystal orientation, and these parts are machined and assembled to close tolerances.

Four conditions are obtained by alignment:

Condition	Tolerance
a) Intersect center of X-ray beam and rotation axis of sample barrel in "V" block	±3mm
b) Intersect center of X-ray beam and rotation axis of θ (sample) circle	±2mm
c) Place center of detector window in the same plane as the incident and diffracted X-ray beams	±5mm
d) Calibrate angle ring on 2θ (detector) circle	±2°

*Conditions a, b, & c are obtained without use of X-rays. Only condition d requires the use of X-rays.

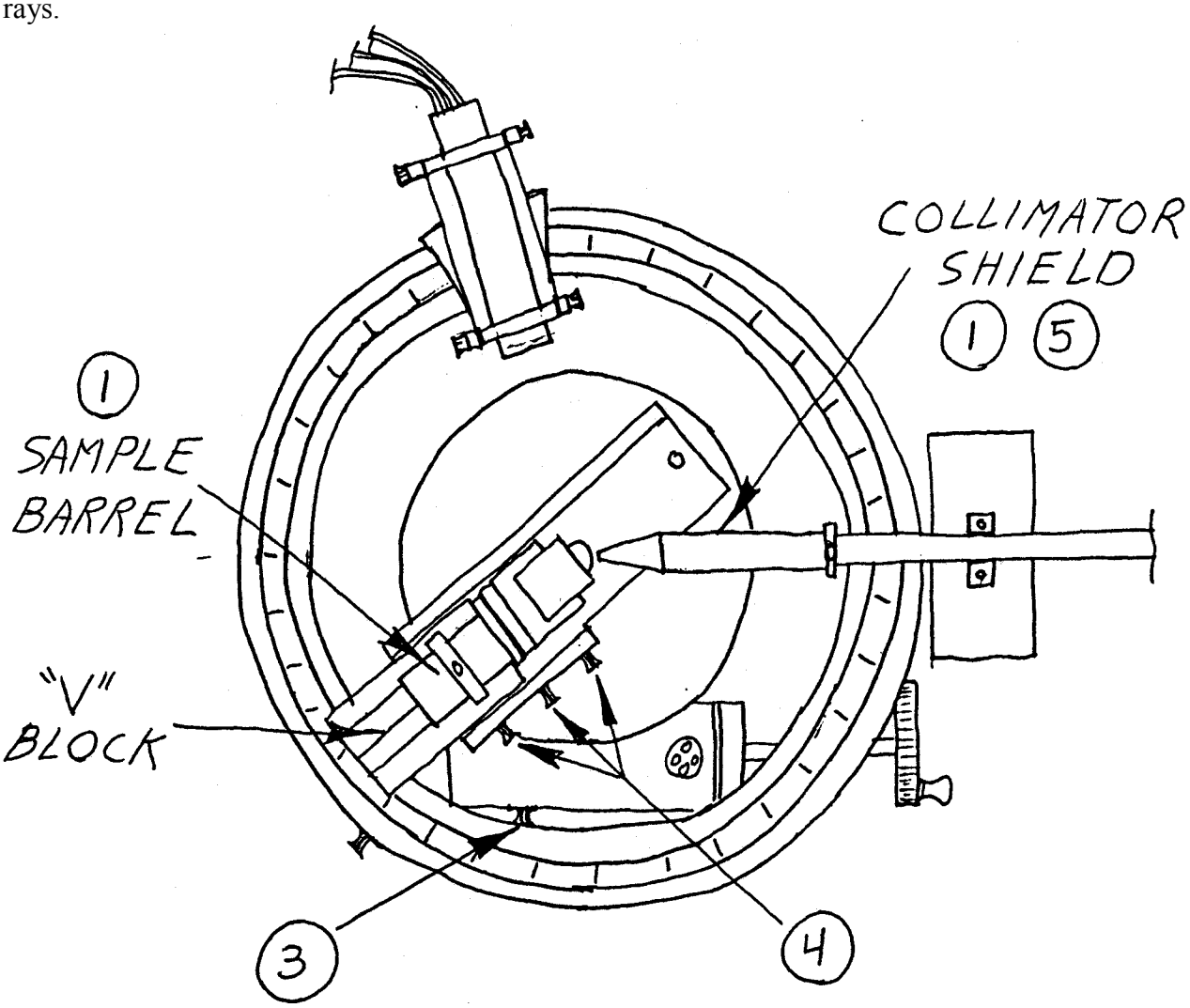


Figure 5 (above)

Procedure:

Intersect center of X-ray beam and rotation axis of sample barrel in "V" block:

1. Fully retract the collimator shield and place the sample barrel in the "V" block.

2. Mark the rotation axis of the sample barrel on its face or use existing machining marks, center-drill holes, etc.

3. Disengage the worm gear drive on the θ circle table and rotate the table so that the collimator axis and the barrel axis are roughly parallel.

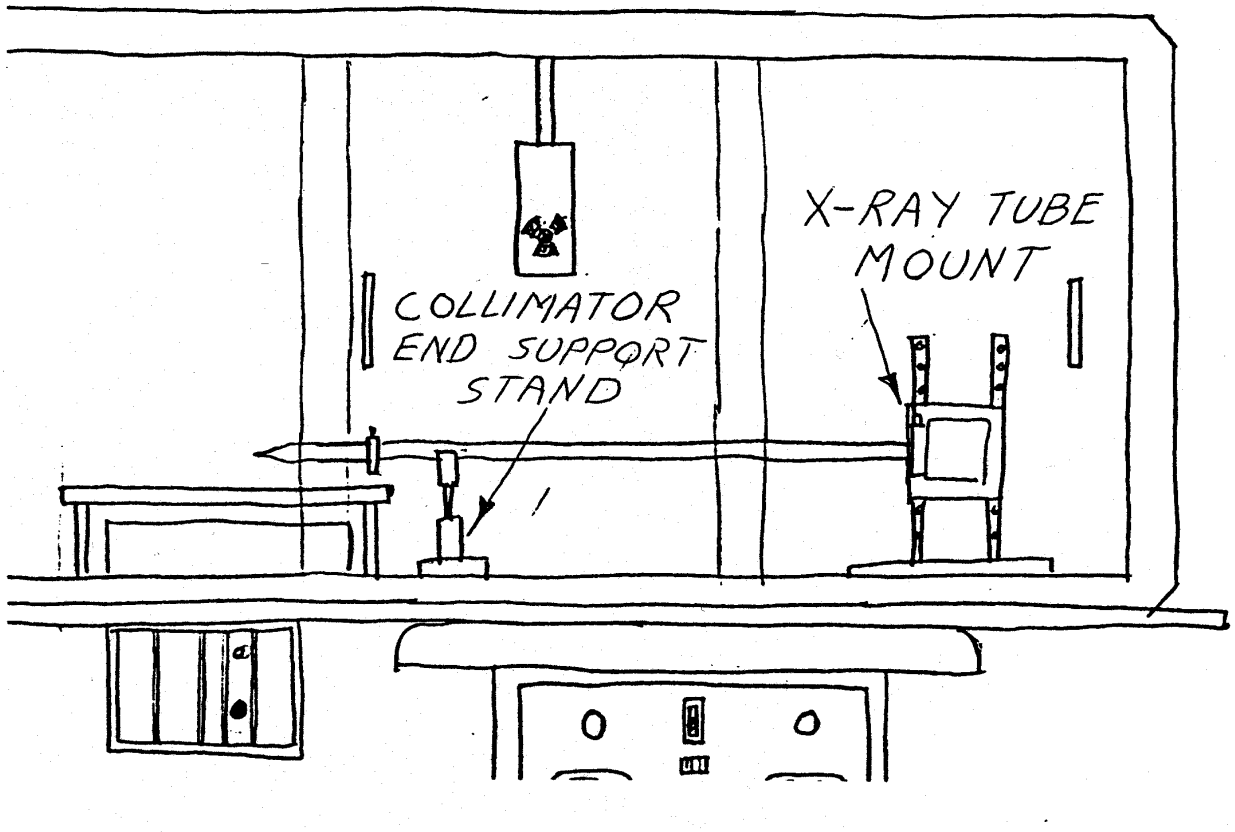


Figure 6 (above)

4. Loosen the brass thumb screws which clamp the "V" block and slide the block so that the face of the barrel is as close as possible to the collimator.

5. Extend the collimator shield to within a few mm of the barrel face and tighten the shield clamp screw.

6. Note whether the end of the collimator shield and the barrel-axis mark lie in a common horizontal plane, within 3mm.

7. If not, retract the collimator shield enough to prevent any collision and carefully raise or lower the X-ray tube mount and collimator end support stand. Before loosening the flange bolts which mount the tube housing to its aluminum right-angle bracket, it is wise to insert a lab jack or other support beneath the flange to support the weight, and help control the motion. Once the tube housing has been moved, readjust the collimator end

support stand to bring the collimator tube ≈horizontal, as measured with a simple spirit level.

8. Repeat steps 5 thru 7, until step 6 is satisfied.

Intersect Center of X-ray Beam and Rotation Axis of θ Circle:

1. Fully retract the collimator shield and remove the "V" block and sample barrel from the θ circle table.

2. Disengage the worm gear drive of the θ circle table and rotate the table so that the steel track runs approximately at right angles to the incident X-ray beam direction, with the end with the brass thumb screws toward the front of the enclosure.

3. Place the centering point fixture (see Figure 7) on the θ circle table track and slide it to its alignment pin.

4. Extend the collimator shield to within a few mm of the centering point and tighten the shield clamp screw.

5. Viewed from above, note whether the end of the centering point lies in the vertical plane passing through the collimator tube axis, within 2mm.

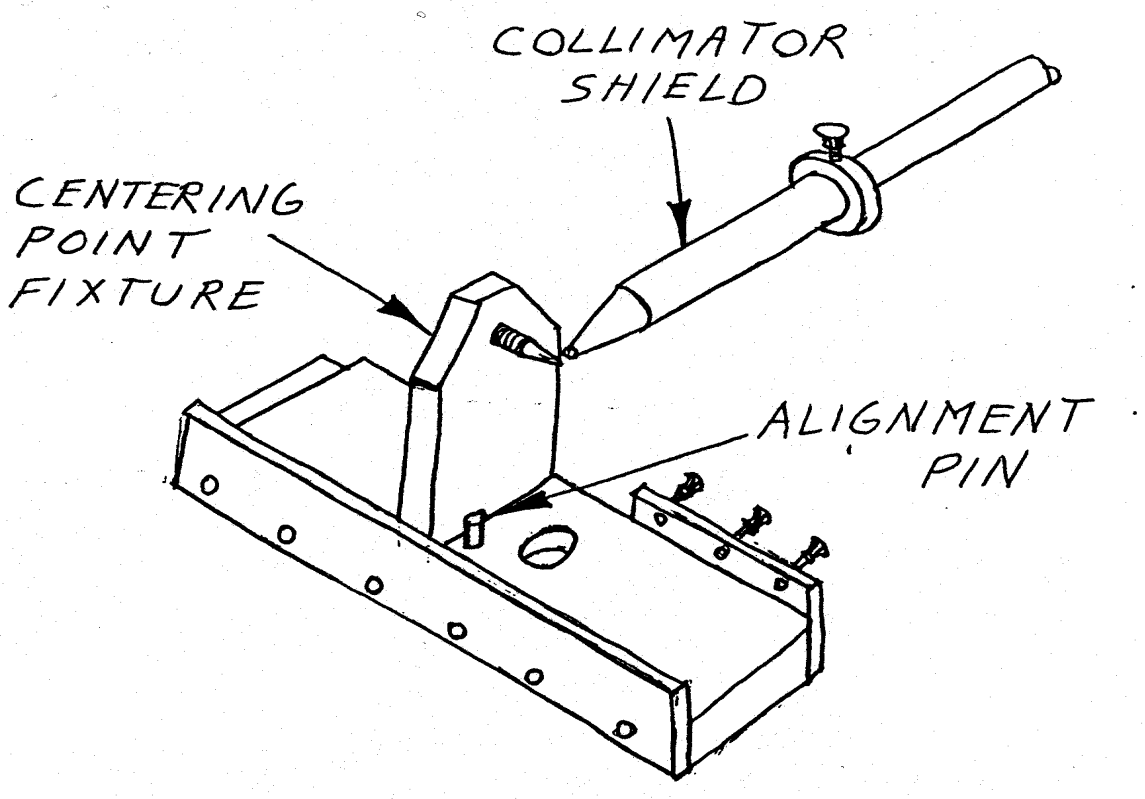


Figure 7 (above)

6. If not, retract the collimator shield 5-10 mm and carefully rotate the tube housing and collimator tube by first lowering the collimator end support stand and removing it from under the collimator tube. Then rotate the X-ray tube housing by gently pushing or pulling on the tube housing near the location of the electric shutter (longest lever arm).

7. Repeat steps 4 thru 6 until step 5 is satisfied.

8. Re-install the collimator end support stand and re-level the collimator tube with a spirit level.

9. Repeat step 5, and move the collimator end support stand slightly if step 5 is not satisfied.

Place Center of Detector Window in the Same Plane as the Incident and Diffracted X-ray Beams:

1. Fully retract the collimator shield.

2. Move the detector on the 2θ circle to about the 140-150° position.

3. As viewed from the 270° mark on the 2θ circle, in a horizontal plane, note whether the center of the collimator shield and the center of the detector window lie in a common horizontal plane, within 5mm.

4. If not, move the detector up or down as required, using the four brass thumbscrews on the detector vertical supports.

Calibrate Angle Ring on 2θ Circle:

1. Remove any crystal holder from the θ circle and rotate the θ circle such that the incident X-ray beam will be unobstructed by anything on the θ circle.

2. Place a temporary horizontal defining slit, 1 mm wide, across the center of the detector. (Pb tape or Pb strips work well).

3. Rotate the detector on the 2θ circle so that it can intercept the incident X-ray beam. (≈0° position)

4. Energize the detector electronics.

5. Perform steps 1-14 of the "Normal Operating Procedures" to start up the X-ray generator.

6. Be certain that the "Kilovolts" and "Milliamperes" controls remain at their minimum positions, 10 kV and 6 mA.

7. Continue with steps 15-23 of the Normal Operating Procedures to get X-rays into the enclosure and override the enclosure interlock.

   Note: operator must be wearing a dosimeter ring to perform the next steps.

8. Perform a radiation survey the base of the detector mount on the 2θ circle to assure that scatter does not exceed 500 counts/min.

9. Loosen the thumb screw on the base of the detector mount and move the detector on the 2θ circle to peak its output reading.

10. Tighten the thumbscrew on the base of the detector mount, and shutdown the X-ray generator.

11. Loosen the thumbscrew which locks the angle ring in the 2θ circle, and rotate the ring so that the 0° mark is under the CCW edge of the brass detector base (as viewed from above).

12. Tighten the thumbscrew on the 2θ angle ring.

Interlock Test Procedure:

Note #1

The Steward of the crystal alignment facility shall conduct this interlock test procedure every 6 months.

Note #2

A Radiological Control Technician shall conduct a radiation survey every 6 months.

Note #3

The NSLS Personnel Protection System (PPS) database administered by the NSLS QA Group shall schedule and track the interlock tests and radiation surveys.

Introduction:

This procedure is designed to test the following subsystems:

a) Rigaku fail-safe enclosure interlocks

b) Fail-safe "X-rays On" lamp in enclosure

c) Blake electric shutter

These procedures do not require that X-rays be present within the enclosure during the tests, however, technically, several tests are performed in "open beam" conditions; the X-ray tube will be running. Therefore a radiation survey meter should be used prior to reaching into the enclosure to assure that scatter does not exceed 500 cpm; **the operator must wear a ring dosimeter.**

Rigaku Fail-Safe Enclosure Interlock:

1. Perform steps 1-14 of the Normal Operating Procedures to start up the generator.

2. Test the door switch for the front-center sliding panel of the enclosure (DOOR NUMBER 4) by sliding that door more than 20 mm in its channel. Latch relay should drop out (i.e. generator trips off), the Kilovolts and Milliamps meter readings should return to zero, and the water solenoid valve should close.

3. Re-energize the generator by sliding the door back to its previous location and momentarily depressing the Start button on the generator front panel.

4. Repeat steps 2 and 3 for each of the additional six (6) enclosure sliding doors.

DOOR NUMBER	1	2	3	5	6	7
STEP 2						
STEP 3						

5. Test the relay contacts in the Rigaku control that prevent latching of the relay, by leaving one enclosure door opened and depressing the generator Start button. Once the Start button is released, the system should immediately turn off.

6. Test the override circuit from power-off state by leaving one or more enclosure panels open and momentarily depressing the Start button on the generator front panel while turning key on the Rigaku panel. Power should come on and latch, but red "FS Release" lamp on the Rigaku front panel should be flashing.

7. Test override reset circuit by now closing the open enclosure panels. Power should remain on, but red FS Release light should go out and remain off.

8. Test that the override circuit is actually off by opening any enclosure panel. Power should immediately be lost from the generator.

9. Re-energize the generator by closing any open enclosure panels and momentarily depressing the Start button on the generator front panel.

10. Test override disable circuit by now by turning key on Rigaku panel. Red FS Release lamp should begin flashing. Release key and red FS Release lamp should go out, and remain off. Power to generator should remain on throughout.

11. Test override circuit from power-on state by now turning key on the Rigaku panel, and while holding, open one enclosure panel. Release the

key. Red FS Release lamp should be flashing and power should remain on in the generator.

Fail-Safe "X-rays On" Lamp in Enclosure:

1. In preparation for later sections of this test, remove the plastic sign from around the red "X-rays On" lamp in the radiation enclosure by loosening the screw on the upper clamp and sliding the sign down and off.

2. Perform steps 1-14 of the Normal Operating Procedures to start up the generator, and set the "Kilovolts" and "Milliamperes" controls to minimum (fully CCW), 10 kV and 7 mA. CAUTION - X-rays are now being generated within the tube!

3. Do not energize the electric shutter and skip ahead to perform steps 22 and 23 of the Normal Operating Procedures to override the enclosure interlock, open the front-center panel enough to allow the red lamp to be unscrewed, and survey the region between the opening created and the red lamp.

4. Unscrew the red "X-rays On" lamp inside the enclosure until the lamp goes out. At that time, all power should be lost from the generator.

5. Screw the lamp back in. The power should remain off.

Blake Electric Shutter:

1. Perform steps 1-12 of the Normal Operating Procedures to start up the generator. (At this stage, with the x-ray tube not operating, the electric shutter can be tested.)

2. Turn on the "Power" switch on the electric shutter control box and momentarily depress the x-ray "On" button on the shutter control box to open the electric shutter. The three red lamps should light as the shutter opens.

3. Switch the "Power" switch off. The shutter should close. Switch it back on, and the shutter should remain closed.

4. Repeat step 2 above and then unplug the power supply for the shutter control box. The shutter should close. Plug it back in. The shutter should remain closed.

5. Repeat step 2 above and then disconnect the gray cable from the shutter control box. The shutter should close, reconnect the gray cable to the shutter control box. The shutter should remain closed.

SIGNED: _____

PRINT NAME: _____

LIFE/GUEST #: _____

DATE: _____

NSLS REVISION & PERIODIC REVIEW LOG

Document Number:	LS-ES-0001
Subject:	Normal Operating Alignment and Interlock Test Procedures: NSLS X-ray Generator for Crystal Orientation, building 535C (Basement)

> See NSLS Quality Control Coordinator for original revision and review signatures <

REVISION TABLE

Rev	Description	Date
B	a) Reformatted document and included new header required b) Incorporated revision and review log.	03/03/2000
C	a) Reformatted document to exclude old generator and include new generator. b) Changed shutdown procedure. c) Deleted door switch access panels on test procedure.	04/18/2000
D	Brought this procedure into conformance with HP-SOP-28, "Radiation Generating Devices" with assistance of SME, Chris Weilandics	04/17/2003

PERIODIC REVIEW TABLE

Complete this table to record the completion of periodic reviews for an existing controlled document. A successful periodic review will reveal the existing document is current, correct, and does not require any revision/change.

Document Review Frequency
3 years

Rev	Date	Reviewed By (Print):	Signature:

Subject Area: ***Radiation-Generating Devices***

Procedure/Documentation Requirements (PDRs) Template for Radiation-Generating Device (RGD) Operation

Effective Date: **July 2004**

Point of Contact: Radiological Control Division Manager

The Procedure/Documentation Requirements (PDRs) Template for Radiation-Generating Device (RGD) Operation is provided as a Word or PDF file.

Back to Top

1.0-072004/standard/3w/3w07e011.htm

Procedure/Documentation Requirements (PDRs) Template for Radiation-Generating Device (RGD) Operation

Department/Division: Location: Bldg.:

Room no.:

Program/Facility:

RGD Manufacturer:

RGD Model: **Serial no.:**

Responsible Person: Department/Division Custodian :

Experimental Safety Review (ESR) (reference – may or may not include SOP, depending on departmental protocols):

Standard Operating Procedure (SOP) (reference – or, may be incorporated directly into the Procedure/Documentation Requirements. It must include the following, as a minimum):

Device/Equipment Description:
Manufacturer
Model
Serial number

Operating Requirements:
Shielding
Periodic maintenance

Operating Protocols:
Alignment
Calibration
Include personnel and equipment safety requirements as they occur during operations: special dosimetry during alignment, precautions for non-routine operation, resurvey after shielding modification, etc.

Safety requirements:
Periodic Interlock check protocols and frequency
Periodic and non-routine radiological surveys requirements
Personnel Dosimetry
Maintaining exposures ALARA

Emergency Conditions and responses:

Refer to Building/Facility Emergency Plan requirements
Contact identification: Facility Rep., Dept. ES&H Coordinator, Emergency Management, etc.
Types of Off/Normal and Emergency situations
- Power interruption, excursion
- Instrument failure
- Safety device failure
- Alarm Response (RGD or local facility)

Documentation:
Instrument Manufacturer's Documentation: (Operators' manuals reference, Manufacturer's schematics reference)
Record keeping – including operation and maintenance log, interlock checks, operator(s)' signatures, dates.
Attached list of trained, qualified operators.
Training records

Procedure/Documentation Requirements (PDRs) Template for Radiation-Generating Device (RGD) Operation

Standard Operating Procedure (SOP) (continued):

Training Requirements:
- Department/Division specific training
- Instrument/installation specific training
- RGD safety training

Attached list of trained, qualified operators.

Signatures: Department/Division RGD Custodian (Review)
Master RGD Custodian (Review)
Facility Support Services (Review)
Department/Division ESH/ERC (Approval)

Subject Area: ***Radiation-Generating Devices***

Radiation-Generating Device (RGD) Exempt Label

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

The Radiation-Generating Device (RGD) Exempt Label is available from Facility Support.

Back to Top

1.0-072004/standard/3w/3w01e011.htm
1.0-072004/standard/3w/3w01e011.gif

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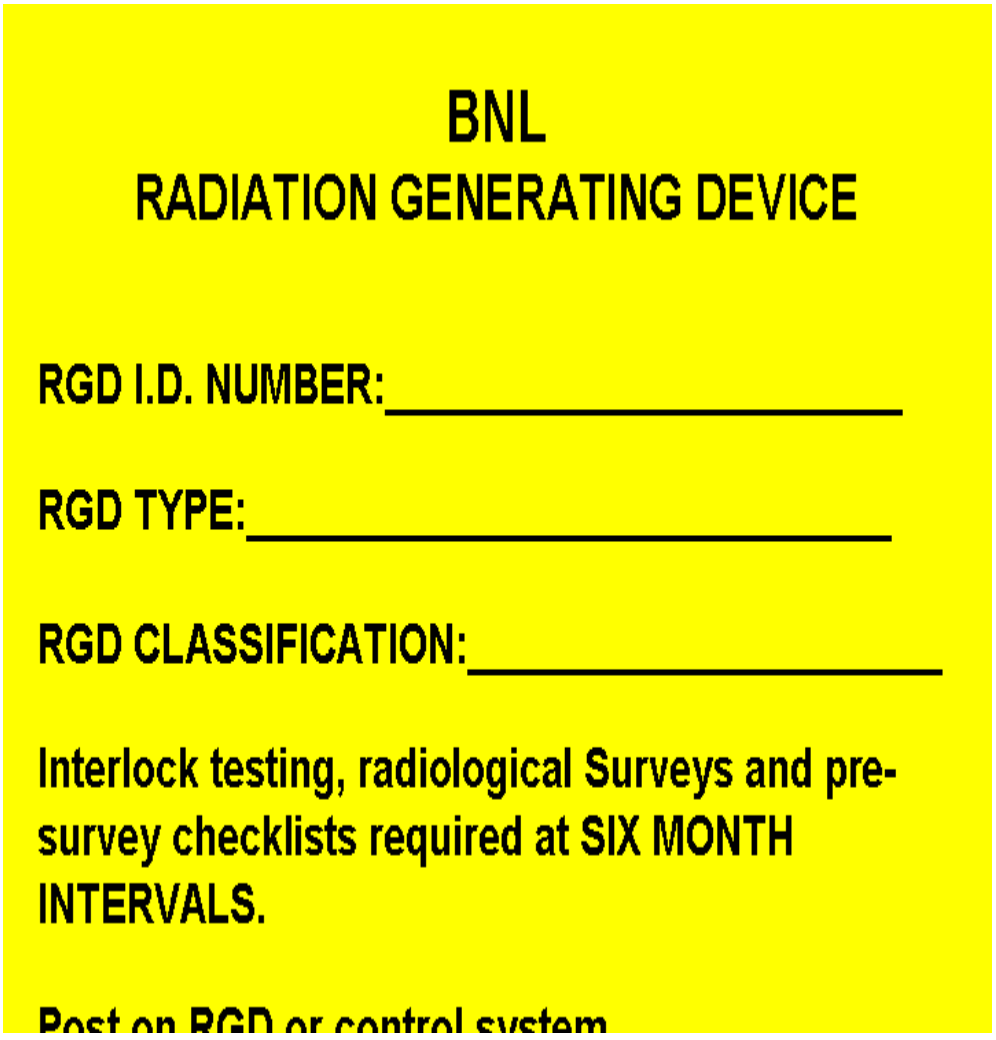
Subject Area: ***Radiation-Generating Devices***

Radiation-Generating Device (RGD) Identification Label

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

The Radiation-Generating Device (RGD) Identification Label is available from Facility Support.



Post on RGD or control system.

Back to Top

1.0-072004/standard/3w/3w03e011.htm
1.0-072004/standard/3w/3w03e011.gif

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Subject Area: ***Radiation-Generating Devices***

Radiation-Generating Device (RGD) Program Exemptions

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

The exhibit Radiation-Generating Device (RGD) Program Exemptions is provided as a PDF file.

Back to Top

1.0-072004/standard/3w/3w02e011.htm

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Radiation-Generating Device (RGD) Program Exemptions

Reasons for Exemptions

If the design of the facility cannot be upgraded in a practical manner to meet the 10 CFR 835 criteria, as specified in the BNL Radiological Control Manual (RCM) and site procedures, then the alternative is the implementation of additional access and occupancy controls to meet the design.

ANSI N43.2 and N43.3 provide specific guidance that should be considered for exempt shielded (including cabinet x-ray), shielded, unattended, and open installations. Should any conflict exist between the requirements and guidance provided in these standards and the requirements of the Brookhaven National Laboratory (BNL) Radiological Control Program and site procedures, then the requirements of the BNL Radiological Control Program and site procedures take precedence.

Requests for exemption will be considered on a case-by-case basis. If the request is granted, the requester will be advised, in writing, by the Radiological Control Division (RCD) Manager, that the device has been exempted from all but the following requirements of the RGD Program:

- Registration in the RGD or sealed source database for tracking purposes.
- Labeling.
- Notification of the Master RGD Custodian regarding changes in use, transfer, storage, disposal, or loss of an RGD.

Requests For Exemptions

The owner of the device submits an exemption request for RGD program exemption to the RCD Manager. In addition, the request includes the following:

- The area, building, or operation involved.
- Specific standard or requirement that makes the exemption necessary.
- A description of the condition, process, or activity that needs an exemption.
- Measures in place to provide adequate protection and to reduce the risk to an acceptable level, or the reason that equivalent measures are not required.
- The reason that the requirement is not applicable or that it may, in fact, decrease safety.
- A cost-benefit analysis, if appropriate.
- A statement of whether the hazard mitigation is equivalent and, if not, a qualitative assessment of the residual risk.

Examples

The following devices <u>may</u> be exempt from classification as an RGD:

- Devices for which a documented analysis shows that the worst-case accident would result in a deep dose to the whole body of no more than 10 mrem, a dose to the lens of the eye of no more than 30 mrem, and a dose to the skin or any extremity of no more than 100 mrem.

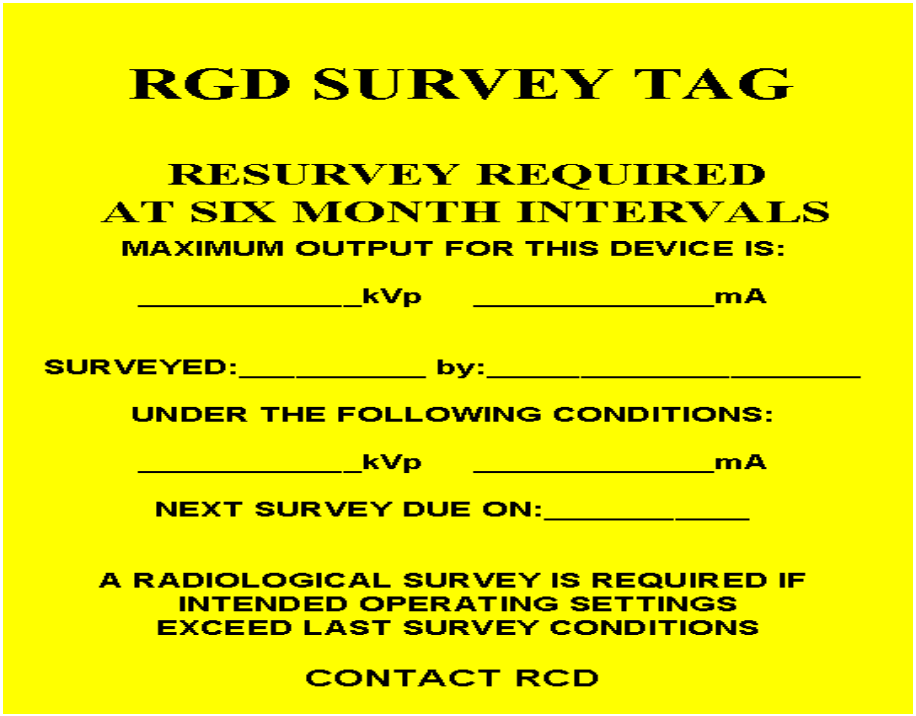
Subject Area: ***Radiation-Generating Devices***

Radiological Survey Tag

Effective Date: **July 2004**

Point of Contact: Radiological Control Division Manager

The Radiological Survey Tag is available from Facility Support.



Back to Top

1.0-072004/standard/3w/3w10e011.htm

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Subject Area: ***Radiation-Generating Devices***

BNL Radiation-Generating Device (RGD) Registration Form

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

The BNL Radiation-Generating Device (RGD) Registration Form is provided as a Word or PDF file.

Back to Top

1.0-072004/standard/3w/3w04e011.htm

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BNL RADIATION-GENERATING DEVICE (RGD) REGISTRATION FORM

RGD Information

Department/Division: _____ Facility Name: _____

Model #: _____ Rm./Location: _____ Bldg.#: _____

Manufacturer _____ Serial #: _____

For devices: Mfg. Rating: _____ kV _____ mA Energy range : _____ keV

For sources: Isotope: _____ Activity: _____ mCi Date In Service: _____

Status: Active ☐ Out of Service (non-functional) ☐ Out of Service (Administrative) ☐

Classification Information
(Top line for RCD entry)

Check All That Apply

☐ **Shielded Installation**	☐ **Exempt Shielded Installation**	☐ **Open Installation**
☐ Source Irradiator*****	☐ Electron beam welder	☐ Portable/Mobile Device
☐ Analytical X-Ray Device	☐ RF/Microwave Cavity	☐ Fixed Device w/Partial Shielding
☐ Accelerator(< 10 MeV)	☐ Diffraction/Fluorescence	☐ Electron Microscope
☐ D-T Neutron Generator	☐ Produces X-rays incidentally	☐ Other

RGD Custodian Information

RGD Custodian: _____ _____ Org._____
LAST FIRST

Bldg/Room: _____ Phone _____

Dept./Div. RGD Custodian _____ _____ Org._____
LAST FIRST

Bldg/Room _____ Mail _____ Phone _____

Procedures and Documentation

Initial PDR Title: _____ Effective Until: _____
Month Date Year

Author(s): _____ Doc. No. _____

To be completed by FS Personnel: Please attach copies of the RGD Survey and Pre-Survey checklist.

FS Rep Signature: _____ Date: _____

*****(For Irradiators) SRS ID#: _____

Comments/Notes

(Form completed by) Signature/Date:_____ Life No.:_____

Dept./Div. RGD Custodian Signature/Date:_____ Life No.:_____

Subject Area: ***Radiation-Generating Devices***

Radiation-Generating Device (RGD) Authorized User Qualification List

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

The Radiation-Generating Device (RGD) Authorized User Qualification List is provided as a Word or PDF file.

Back to Top

1.0-072004/standard/3w/3w09e011.htm

Radiation-Generating Device (RGD) Authorized User Qualification List

Personnel qualified to work with this RGD system are listed below. These qualified RGD Operators must understand the information and conform to the requirements contained in the applicable PDR/ESR/SOP. For training, enter the date of completion. The details of the RGD-specific training are documented using a separate training checklist.

RGD Information

Department/Division: _____ Facility Name: _____

Model #: _____ Rm./Location: _____Bldg.#: _____

Manufacturer _____ Serial #: _____

Qualified RGD Operators (see individual training checklists for level of training):

Basic RGD Training	Printed Name	Life Number	Signature	Owner/ Operator Initial/date

Subject Area: ***Radiation-Generating Devices***

Radiation-Generating Device (RGD) System-Specific Training Checklist

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

The Radiation-Generating Device (RGD) System-Specific Training Checklist is provided as a Word or PDF file.

Back to Top

1.0-072004 - File Name Not Found

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Radiation-Generating Device (RGD) System-Specific Training Checklist

RGD User:	
RGD Owner:	
RGD System/ID#:	

Topic	User Signature / Date	Owner Signature / Date
General RGD Safety • RGD hazards • Maintenance log updates • Dosimetry • Good practice in the lab • RGD PRD/SOP/RWP review		
RGD Interlock Instruction (if applicable) • Configuration • Operation • Interlock test period		
Description of RGD Output Characteristics • Type(xray, γ, neutron, etc.) • Dose rates in-beam, around device • Radiological areas • Postings/labels		
Associated electrical hazards • Power supply • detectors		
Normal Operation • Power on/off • Shutter operation • Normal experimental configuration • Nominal hazard zone		
Non-Normal Operation* • Gross alignment • Troubleshooting • Contact FS before restart		

** Only those users who have completed the Non-Normal Operation portion of the RGD-specific training may perform gross alignment procedures as defined in the Standard Operating Procedure.*

Definitions: Radiation-Generating Devices

Effective Date: **July 2004**
Point of Contact: Radiological Control Division Manager

Term	Definition
cabinet x-ray system	An x-ray system with the x-ray tube installed in an enclosure (hereinafter termed "cabinet") which, independently of existing architectural structures except the floor on which it may be placed, is intended to contain at least that portion of a material being irradiated, provide radiation attenuation, and exclude individuals from its interior during generation of x-radiation. Included are all the x-ray systems designed primarily for inspection of carry-on baggage at airline, railroad, and bus terminals, and in similar facilities. An x-ray tube used within a shielded part of a building or x-ray equipment that may temporarily or occasionally incorporate portable shielding is not considered a cabinet x-ray system.
enclosed (closed) beam	The radiation source, sample, and detector (if used) are enclosed in an exempt shielded enclosure or chamber that prevents inadvertent entry of any part of the body during normal operations.
exempt shielded	Those designed to fully enclose the specimen to be irradiated and to provide adequate shielding such that the dose at any accessible region two inches (5 cm) from the surface of the enclosure does not exceed 0.5 mrem in any one hour. This type has the added advantage of not requiring restrictions in occupancy outside the enclosure.
Facility Use Agreement (FUA)	FUA defines the operational safety envelope for each building and establishes an agreement among the occupants and support services for conducting activities/work within this framework. The FUA functions as an integrating reference document that links building-specific operational criteria with Laboratory-wide management systems and information resources.
interlock (operational check of safety devices)	A device for precluding access to an area of radiation hazard by either preventing entry or by automatically removing the hazard. One example is an electromechanical control mechanism that interrupts the beam of ionizing radiation or shuts down the radiation installation whenever the interlock is challenged.

irradiator	Sealed radioactive material that has the potential to create a radiation level exceeding 500 rads (5 grays) in 1 hour at 1 meter.
Lead Experimenter (LE)	The Lead Experimenter (LE), alternately, Responsible Person (RP), is that person who takes the responsibility for all the members of a team that carry out an experiment, experimental program, or work at BNL. The LE/RP must be able to act as the spokesperson for their experiment for the purposes of this subject area. The LE/RP must be knowledgeable about the technical details of the experiment and aware of the associated hazards.
modification	Any alteration of the shielding configuration, device or installation operating practices, or the replacement of the original RGD (or component part thereof) with another that has not been previously evaluated, inspected, monitored, and documented by the facility's Responsible Person.
normal operation	Operation under conditions as recommended by the manufacturer of the RGD with recommended shielding and barriers in place, and as specified in the operating procedures and requirements for the RGD installation.
occupied (occupiable) area	An area or location that may be physically accessible by individuals (or body parts thereof) while a radiation-generating device is in operation.
off-normal operation	An event or condition that adversely affects, potentially affects, or indicates degradation in the safety, security, environmental, or health-protection performance or operation of an RGD installation.
open installation	Those designed to accommodate a specimen that is so large as to make an exempt shielded installation impractical.
radiation-generating device (RGD)	Collective term for devices which produce ionizing radiation, including, certain sealed radioactive sources, small particle accelerators (less than 10 MeV) used for single purpose applications which produce ionizing radiation (e.g., radiography), and electron generating devices that produce X rays incidentally. Devices that are considered RGDs include 1. Devices that produce X rays incidentally. Examples are ○ Electron microscopes ○ Electron beam welding machines ○ RF and microwave cavities that produce X rays ○ Pulse generators ○ Unshielded electron beam devices with energies greater than 5 kV 2. Devices that produce X rays intentionally. Examples are ○ X-ray producing radiography equipment ○ Research and analytical x-ray or electron beam machines (X-ray diffraction and fluorescence analysis

	systems) ○ Cabinet x-ray machines used for security applications ○ Neutron generating devices such as D-T generators 3. Devices that are not considered RGDs. ○ Sealed radioactive sources that do not meet the definition of an irradiator; these sources are covered in BNL's Sealed Radioactive Source Control Subject Area. A. Vacuum gauges. B. Commercial equipment such as television receivers, computer video monitors, microwave ovens, copiers, and CRTs, such as laboratory monitors and oscilloscopes. Unmodified commercially available incidental radiation-generating devices with energies <=15 kV that produce no significant radiation fields above background when measured 5 cm (2 in.) from the device surface (or at the closest accessible surface) and when operated at the maximum approved operating parameters. Examples of devices that may fit into this category are high-voltage switches and power supplies containing various types of thermionic valves installed in shielded cabinets or racks, mass spectrometers, vacuum switches, and spark-gap devices. Devices should be reviewed to determine if they fit into this category.
radiography (industrial)	Examination of the structure of materials by nondestructive methods, using a radiation-generating device (RGD).
Responsible Person (RP)	See definition for Lead Experimenter (LE).
RGD Custodian	An individual who is trained and designated to maintain cognizance over accountability and control of radiation-generating devices assigned to him or her. Department/Division Custodian: a Department/Division-level person who is responsible for maintaining the Department/Division list of radiation generating devices and relaying this information to the Master RGD Custodian for RGDs. Master RGD Custodian: A Laboratory-level person responsible for maintaining the site inventory of radiation-generating devices.
RGD installation	The sum of the radiation source (e.g., sealed radioactive material or x-ray tube), the associated equipment and component items, and the space in which they are operated.
RGD Operator	A Radiological Worker who is trained and qualified by the Department/Division and the Department/Division RGD Custodian to use a specific radiation-generating device.
shielded Installation	Those designed to use the room-within-a-room concept to limit access to the RGD beam and to place more emphasis on distance

	as opposed to shielding for radiation protection. This design includes the use of interlocks and the use of audible and/or visible warning signals.
unattended installation	Those designed usually for a specific purpose and that do not require personnel in attendance for operation. Their design assures that personnel in the area are not exposed to doses exceeding 100 mrem/year, typically by keeping the primary beam radiation in a location away from occupied areas, sufficient shielding of the source housing or tube assembly, and administrative procedures.

Back to Top

1.0-072004/standard/3w/3w00l011.htm

Revision History: Radiation-Generating Devices

Point of Contact: Radiological Control Division Manager

Revision History of this Subject Area

Date	Description	Management System
July 2004	Many devices that are in use at BNL produce ionizing radiation either intentionally or incidentally as a result of their normal routine operation. This subject area describes the procedures and guidelines for working with radiation-generating devices (RGDs) at BNL, including registration, commissioning, and decommissioning, to ensure regulatory compliance with 10 CFR 835, Occupational Radiation Protection and the BNL Radiological Control Manual. It replaces the current Laboratory Site Wide Standard Operating Procedure HP-SOP-028, Radiation Generating Devices.	Radiological Control

Back to Top

1.0-072004/standard/3w/3w00a011.htm

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